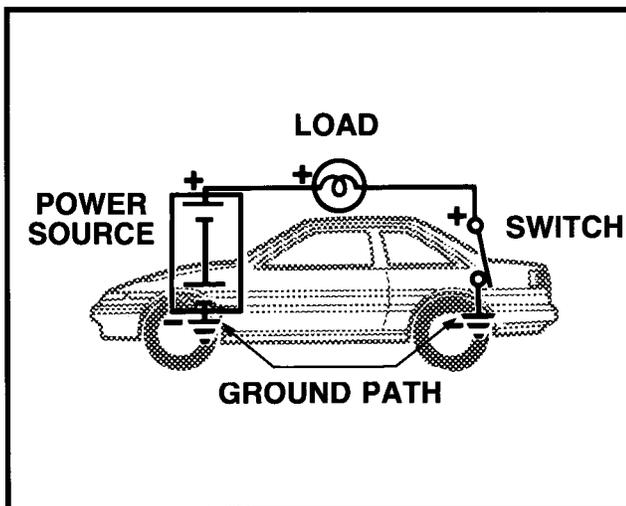
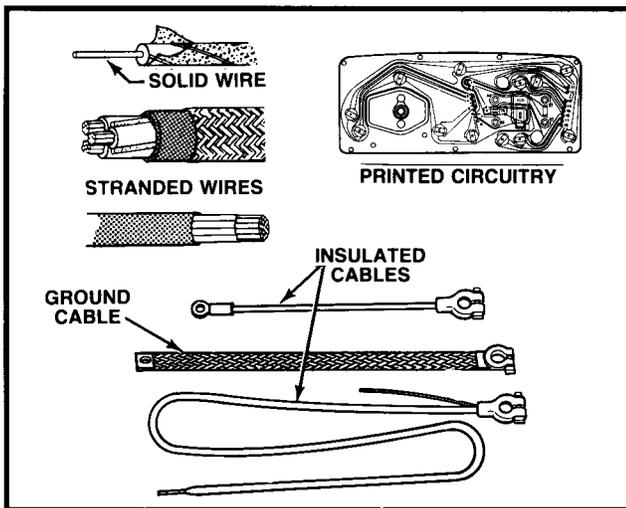


CONDUCTORS

Conductors are needed to complete the path for electrical current to flow from the power source to the working devices and back to the power source.



POWER OR INSULATED CONDUCTORS

Conductors for the power or insulated current path may be solid wire, stranded wire, or printed circuit boards. Solid, thin wire can be used when current is low. Stranded, thick wire is used when current is high. Printed circuitry - copper conductors printed on an insulating material with connectors in place - is used where space is limited, such as behind instrument panels.

Special wiring is needed for battery cables and for ignition cables. Battery cables are usually very thick, stranded wires with thick insulation. Ignition cables usually have a conductive carbon core to reduce radio interference.

GROUND PATHS

Wiring is only half the circuit in Toyota electrical systems. This is called the "power" or insulated side of the circuit. The other half of the path for current flow is the vehicle's engine, frame, and body. This is called the ground side of the circuit. These systems are called single-wire or ground-return systems.

A thick, insulated cable connects the battery's positive (+) terminal to the vehicle loads. As insulated cable connects the battery's negative (-) cable to the engine or frame. An additional grounding cable may be connected between the engine and body or frame.

Resistance in the insulated side of each circuit will vary depending on the length of wiring and the number and types of loads. Resistance on the ground side of all circuits must be virtually zero. This is especially important: Ground connections must be secure to complete the circuit. Loose or corroded ground connections will add too much resistance for proper circuit operation.

SYSTEM POLARITY

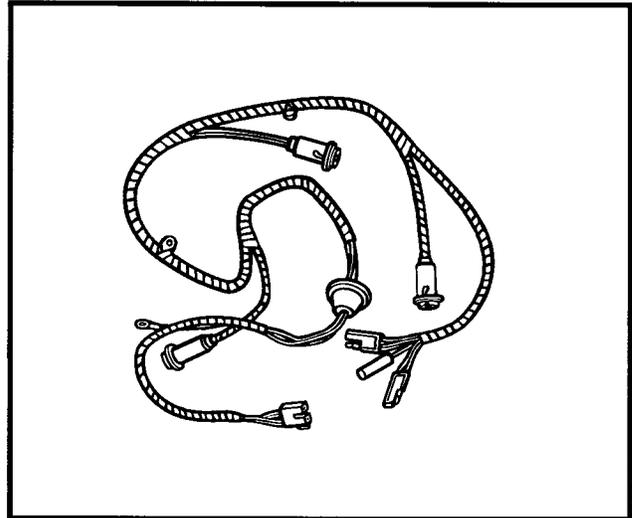
System polarity refers to the connections of the positive and negative terminals of the battery to the insulated and ground sides of the electrical system. On Toyota vehicles, the positive (+) battery terminal is connected to the insulated side of the system. This is called a negative ground system having positive polarity.

Knowing the polarity is extremely important for proper service. Reversed polarity may damage alternator diodes, cause improper operation of the ignition coil and spark plugs, and may damage other devices such as electronic control units, test meters, and instrument panel gauges.

WIRE, TERMINAL AND CONNECTOR REPAIR

HARNESSES

Harnesses are bundles of wires that are grouped together in plastic tubing, wrapped with tape, or molded into a flat strip. The colored insulation of various wires allows circuit tracing. While the harnesses organize and protect wires going to common circuits, don't overlook the possibility of a problem inside.



WIRE INSULATION

Conductors must be insulated with a covering or "jacket." This insulation prevents physical damage, and, more important, keeps the current flow in the wire. Various types of insulation are used depending on the type of conductor. Rubber, plastic, paper, ceramics, and glass are good insulators.

R

RED RED GREEN

R-G

WIRING COLOR CODE

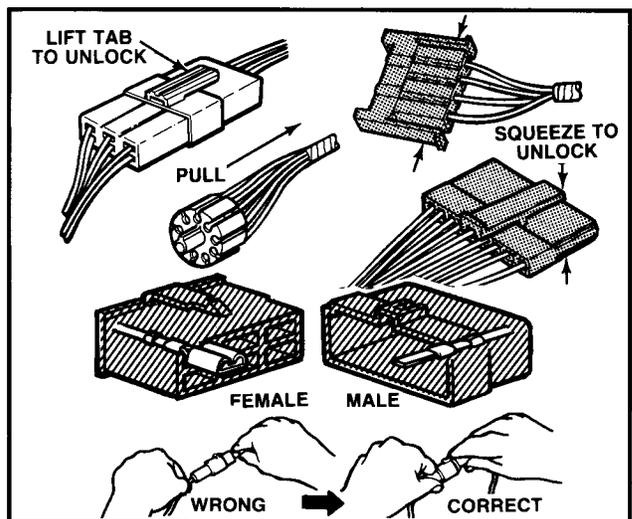
Wire colors are indicated by an alphabetical code.

B = Black	L = Light Blue	R = Red
BR = Brown	LG = Light Green	V = Violet
G = Green	O = Orange	W = White
GR = Gray	P = Pink	Y = Yellow

The first letter indicates the basic wire color and the second letter indicates the color of the stripe.

CONNECTORS

Various types of connectors, terminals, and junction blocks are used on Toyota vehicles. The wiring diagrams identify each type used in a circuit. Connectors make excellent test points because the circuit can be "opened" without need for wire repairs after testing. However, never assume a connection is good simply because the terminals seem connected. Many electrical problems can be traced to loose, corroded, or improper connections. These problems include a missing or bent connector pin.



CONNECTOR REPAIR

The repair parts now in supply are limited to those connectors having common shapes and terminal cavity numbers. Therefore, when there is no available replacement connector of the same shape or terminal cavity number, please use one of the alternative methods described below. Make sure that the terminals are placed in the original order in the connector cavities, if possible, to aid in future diagnosis.

1. When a connector with a different number of terminals than the original part is used, select a connector having more terminal cavities than required, and replace both the male and female connector parts.

Example: You need a connector with six terminals, but the only replacement available is a connector with eight terminal cavities. Replace both the male and female connector parts with the eight terminal part, transferring the terminals from the old connectors to the new connector.

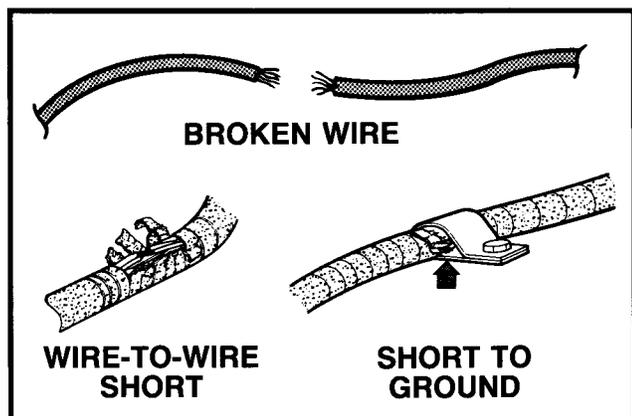
2. When several different type terminals are used in one connector, select an appropriate male and female connector part for each terminal type used, and replace both male and female connector parts.

Example: You need to replace a connector that has two different types of terminals in one connector. Replace the original connector with two new connectors, one connector for one type of terminal, another connector for the other type of terminal.

3. When a different shape of connector is used, first select from available parts a connector with the appropriate number of terminal cavities, and one that uses terminals of the same size as, or larger than, the terminal size in the vehicle. The wire lead on the replacement terminal must also be the same size as, or larger than, the nominal size of the wire in the vehicle. ("Nominal" size may be found by looking at the illustrations in the back of this book or by direct measurement across the diameter of the insulation). Replace all existing terminals with the new terminals, then insert the terminals into the new connector.

Example: You need to replace a connector that is round and has six terminal cavities. The only round replacement connector has three terminal cavities. You would select a replacement connector that has six or more terminal cavities and is not round, then select terminals that will fit the new connector. Replace the existing terminals, then insert them into the new connector and join the connector together.

WIRE, TERMINAL AND CONNECTOR REPAIR



CONDUCTOR REPAIR

Conductor repairs are sometimes needed because of wire damage caused by electrical faults or by physical abuse. Wires may be damaged electrically by short circuits between wires or from wires to ground. Fusible links may melt from current overloads. Wires may be damaged physically by scraped or cut insulation, chemical or heat exposure, or breaks caused during testing or component repairs.

WIRE SIZE

Choosing the proper size of wire when making circuit repairs is critical. While choosing wires too thick for the circuit will only make splicing a bit more difficult, choosing wires too thin may limit current flow to unacceptable levels or even result in melted wires. Two size factors must be considered: **wire gauge number** and **wire length**.

• WIRE GAUGE NUMBER

Wire gauge numbers are determined by the conductor's cross-section area.

In the American Wire Gauge system, "gauge" numbers are assigned to wires of different thicknesses. While the gauge numbers are not directly comparable to wire diameters and cross-section areas, higher numbers (16, 18, 20) are assigned to increasingly thinner wires and lower numbers (1, 0, 2/0) are assigned to increasingly thicker wires. The chart shows AWG gauge numbers for various thicknesses.

Wire cross-section area in the AWG system is measured in circular mils. A mil is a thousandth of an inch (0.001). A circular mil is the area of a circle 1 mil (0.001) in diameter.

In the metric system used worldwide, wire sizes are based on the cross-section area in square millimeters (mm^2). These are not the same as AWG sizes in circular mils. The chart shows AWG size equivalents for various metric sizes.

• WIRE LENGTH

Wire length must be considered when repairing circuits because resistance increases with longer lengths. For instance, a 16-gauge wire can carry an 18-amp load for 10 feet without excessive voltage drop. But, if the section of wiring being replaced is only 3-feet long, an 18-gauge wire can be used. Never use a heavier wire than necessary, but - more important - never use a wire that will be too small for the load.

AMERICAN WIRE GAUGE SIZES

Gauge Size	Conductor Diameter (Inch)	Cross Section Area (Circular Mils)
20	.032"	1,020
16	.051"	2,580
12	.081"	6,530
8	.128"	16,500
2	.258"	66,400
0	.325"	106,000
2/0	.365"	133,000

AWG Size **Metric Size (mm^2)**

20	0.5
18	0.8
16	1.0
14	2.0
12	3.0
10	5.0
8	8.0
6	13.0
4	19.0

WIRE REPAIRS

- Cut insulation should be wrapped with tape or covered with heat-shrink tubing. In both cases, overlap the repair about 1/2-inch on either side.
- If damaged wire needs replacement, make sure the same or larger size is used. Also, attempt to use the same color. Wire strippers will remove insulation without breaking or nicking the wire strands.
- When splicing wires, make sure the battery is disconnected. Clean the wire ends. Crimp and solder them using rosin-core, not acid-core, solder.

• SOLDERING

Soldering joins two pieces of metal together with a lead and tin alloy.

In soldering, the wires should be spliced together with a crimp. The less solder separating the wire strands, the stronger the joint.

• SOLDER

Solder is a mixture of lead and tin plus traces of other substances.

Flux core wire solder (wire solder with a hollow center filled with flux) is recommended for electrical splices.

• SOLDERING FLUX

Soldering heats the wires. In so doing, it accelerates oxidization, leaving a thin film of oxide on the wires that tends to reject solder. Flux removes this oxide and prevents further oxidation during the soldering process.

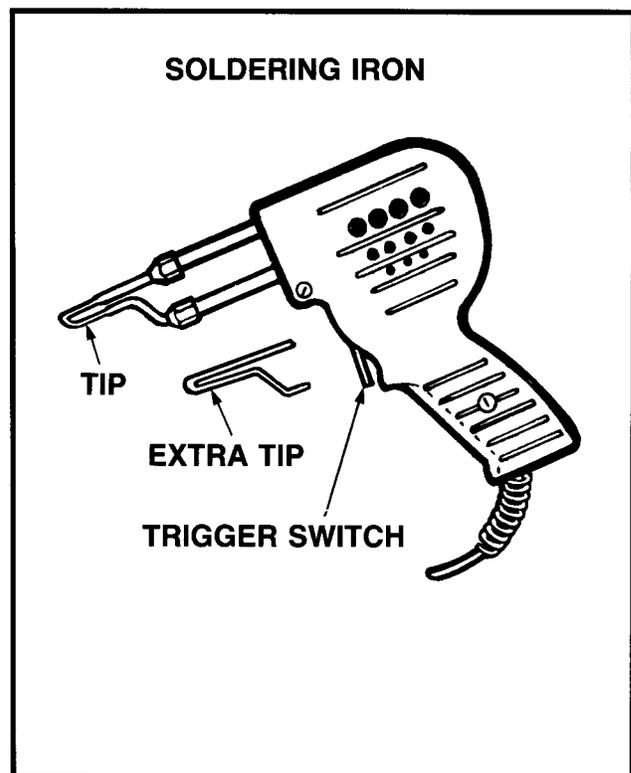
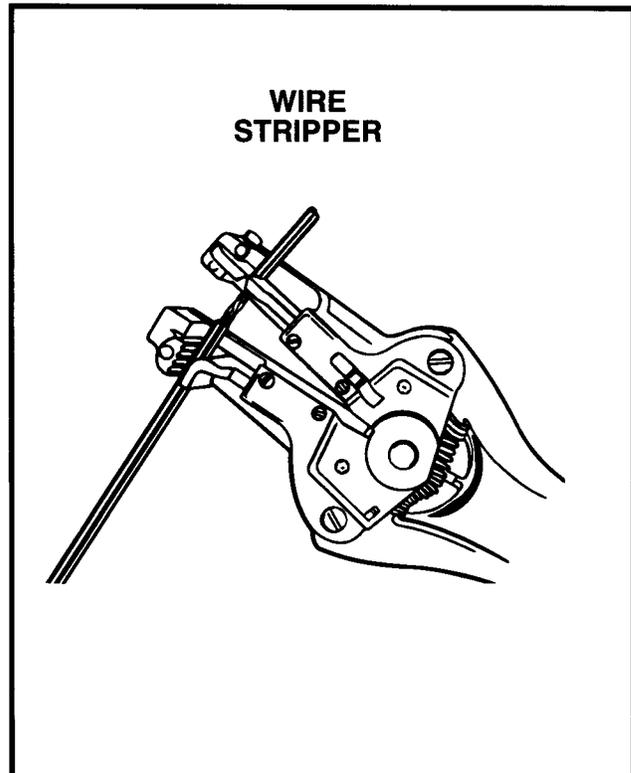
Rosin or resin-type flux must be used for all electrical work. The residue will not cause corrosion, nor will it conduct electricity.

• SOLDERING IRONS

The soldering iron should be the right size for the job. An iron that is too small will require excessive time to heat the work and may never heat it properly. A low-wattage (25-100 W) iron works best for wiring repairs.

• CLEANING WORK

All traces of paint, rust, grease, and scale must be removed. Good soldering requires clean, tight splices.



• TINNING THE IRON

The soldering iron tip is made of copper. Through the solvent action of solder and prolonged heating, it will pit and corrode. An oxidized or corroded tip will not satisfactorily transfer heat from the iron to the work. It should be cleaned and tinned. Use a file and dress the tip down to the bare copper. File the surfaces smooth and flat.

Then, plug the iron in. When the tip color begins to change to brown and light purple, dip the tip in and out of a can of soldering flux (rosin type). Quickly apply rosin core wire solder to all surfaces.

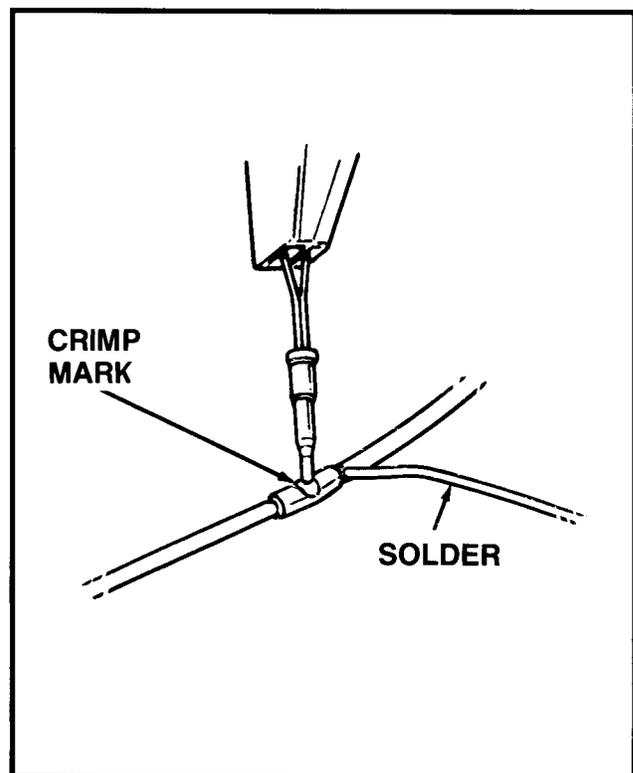
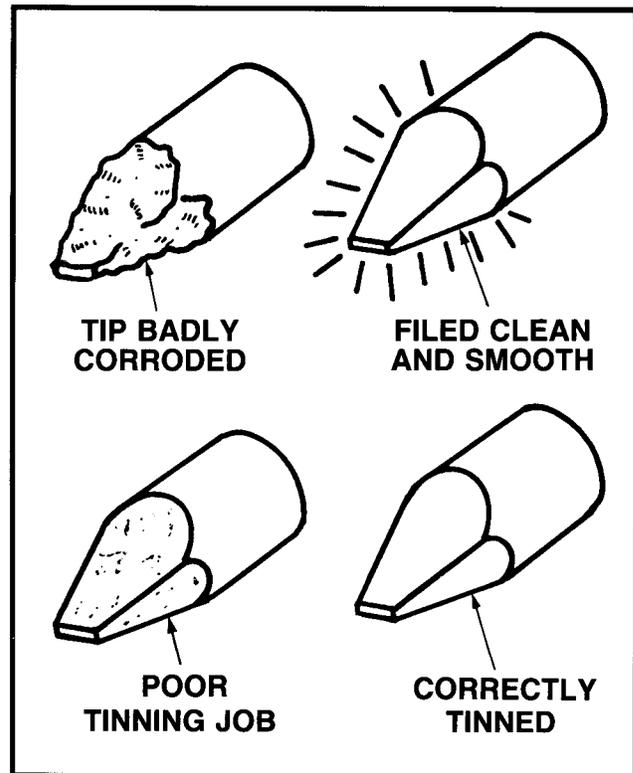
The iron must be at operating temperature to tin properly. When the iron is at the proper temperature, solder will melt quickly and flow freely. Never try to solder until the iron is properly tinned.

• SOLDERING WIRE SPLICES

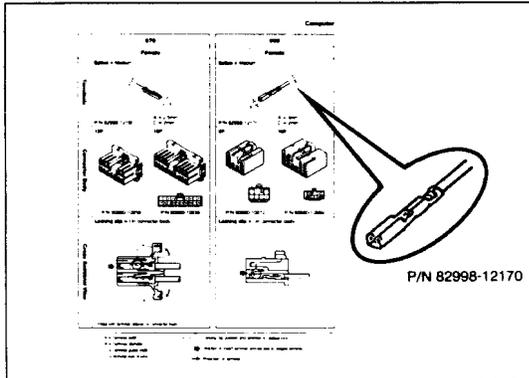
Apply the tip flat against the splice. Apply rosin-core wire solder to the flat of the iron where it contacts the splice. As the wire heats, the solder will flow through the splice.

• RULES FOR GOOD SOLDERING

1. Clean wires.
2. Wires should be crimped together.
3. Iron must be the right size and must be hot.
4. Iron tip must be tinned.
5. Apply full surface of soldering tip to the splice.
6. Heat wires until solder flows readily.
7. Use rosin-core solder.
8. Apply enough solder to form a secure splice.
9. Do not move splice until solder sets.
10. Place hot iron in a stand or on a protective pad.
11. Unplug iron as soon as you are finished.



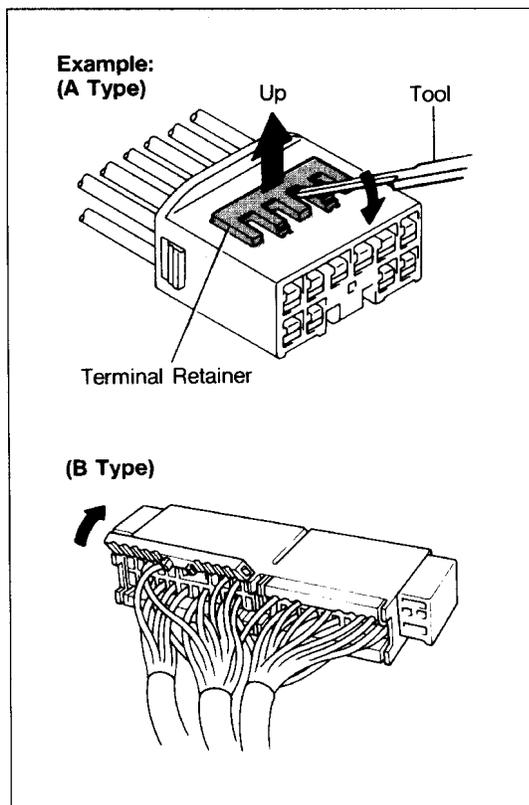
WIRE, TERMINAL AND CONNECTOR REPAIR



Step 1. Identify the connector and terminal type.

1. Replacing Terminals

- a. Identify the connector name, position of the locking clips, the un-locking direction and terminal type from the pictures provided on the charts.



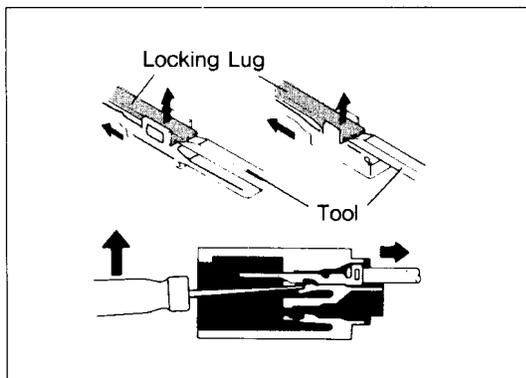
Step 2. Remove the terminal from the connector.

1. Disengage the secondary locking device or terminal retainer.

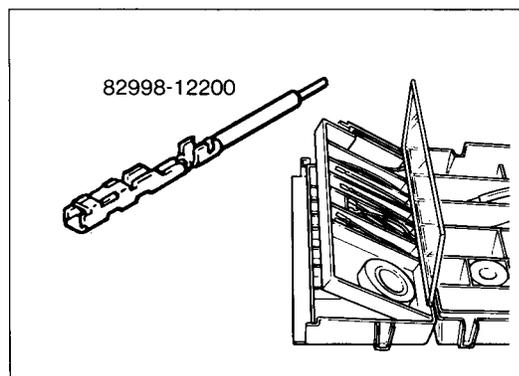
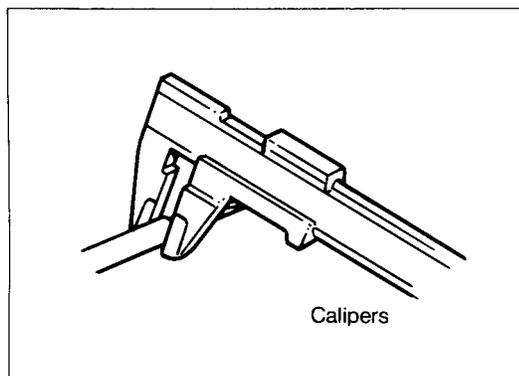
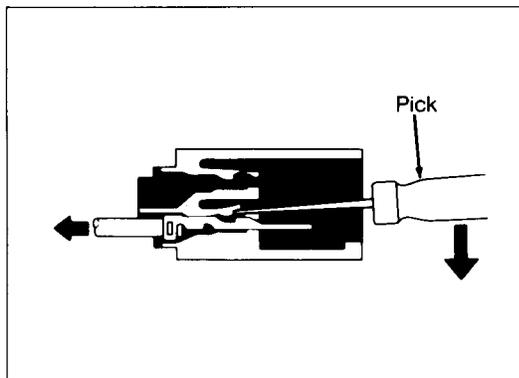
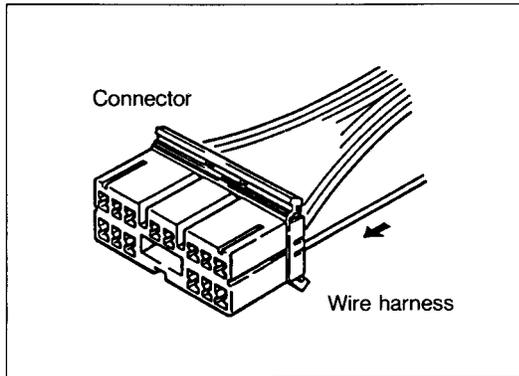
- a. Locking device must be disengaged before the terminal locking clip can be released and the terminal removed from the connector.
- b. Use a miniature screwdriver or the terminal pick to unlock the secondary locking device.

2. Determine the primary locking system from the charts.

- a. Lock located on terminal
- b. Lock located on connector
- c. Type of tool needed to unlock
- d. Method of entry and operation



WIRE, TERMINAL AND CONNECTOR REPAIR



3. Remove terminal from connector by releasing the locking clip.

- Push the terminal gently into the connector and hold it in this position.
- Insert the terminal pick into the connector in the direction shown in the chart.
- Move the locking clip to the un-lock position and hold it there.

NOTE: Do not apply excessive force to the terminal. Do not pry on the terminal with the pick.

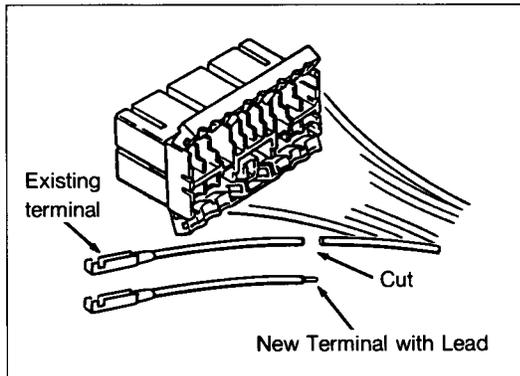
- Carefully withdraw the terminal from the connector by pulling the lead toward the rear of the connector.

NOTE: Do not use too much force. If the terminal does not come out easily, repeat steps (a.) through (d.).

4. Measure "nominal" size of the wire lead by placing a measuring device, such as a micrometer or Vernier Caliper, across the diameter of the insulation on the lead and taking a reading.

5. Select the correct replacement terminal, with lead, from the repair kit.

WIRE, TERMINAL AND CONNECTOR REPAIR



6. Cut the old terminal from the harness.

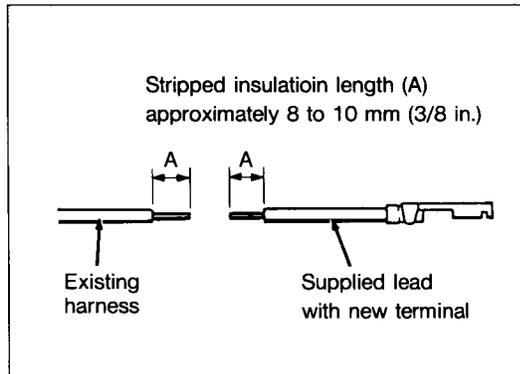
- a. Use the new wire lead as a guide for proper length.

NOTE: If the length of wire removed is not approximately the same length as the new piece, the following problems may develop:

Too short - tension on the terminal, splice, or the connector, causing an open circuit.

Too long - excessive wire near the connector, may get pinched or abraded, causing a short circuit.

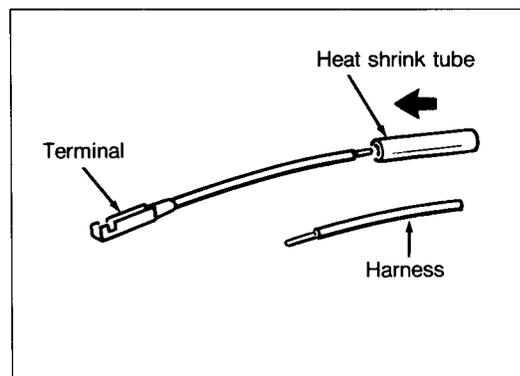
NOTE: If the connector is of a waterproof type, the rubber plug may be reused.



7. Strip insulation from wire on the harness and replacement terminal lead.

- a. Strip length should be approximately 8 to 10 mm (3/8 in.).

NOTE: Strip carefully to avoid nicking or cutting any of the strands of wire.

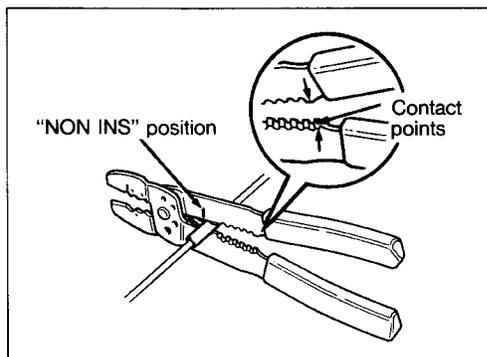
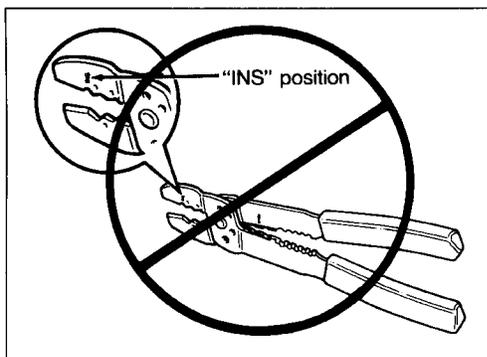
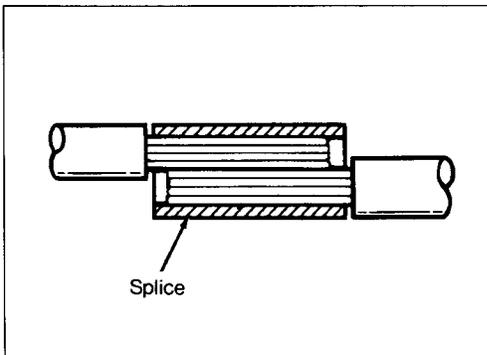
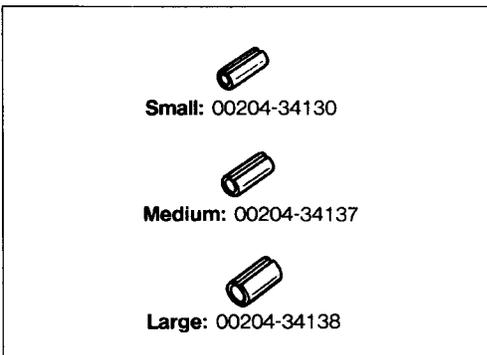


NOTE: If heat shrink tube is to be used, it must be installed at this time, sliding it over the end of one wire to be spliced. (See Step 3, 4. B. 1. for instructions on how to use heat shrink tube.)

NOTE: If the connector is a waterproof type, the rubber plug should be installed on the terminal end at this time.

WIRE, TERMINAL AND CONNECTOR REPAIR

Step 3. Replace the terminal.



1. Select correct size of splice from the repair kit.

a. Size is based on the nominal size of the wire (three sizes are available).

	Part Number	Wire Size
Small	00204-34130	16-22 AWG 1.0 - 0.2 mm
Medium	00204-34137	14-16 AWG 2.0 - 1.0 mm
Large	00204-34138	10 - 12 AWG 5.0 - 3.0 mm

2. Crimp the replacement terminal lead to the harness lead.

a. Insert the stripped ends of both the replacement lead and the harness lead into the splice, overlapping the wires inside the splice.

NOTE: Do not place insulation in the splice, only stripped wire.

b. Do not use position marked "INS".

The crimping tool has positions marked for insulated splices (marked "INS") that should not be used, as they will not crimp the splice tightly onto the wires.

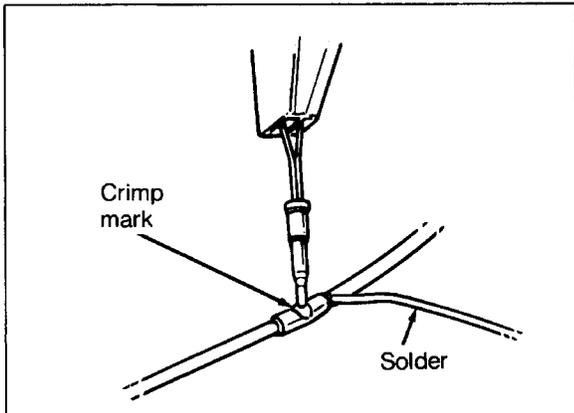
c. Use only position marked "NON INS".

1. With the center of the splice correctly placed between the crimping jaws, squeeze the crimping tool together until the contact points of the crimper come together.

NOTE: Make sure the wires and the splice are still in the proper position before closing the crimping tool ends. Use steady pressure in making the crimp.

2. Make certain that the splice is crimped lightly.

WIRE, TERMINAL AND CONNECTOR REPAIR

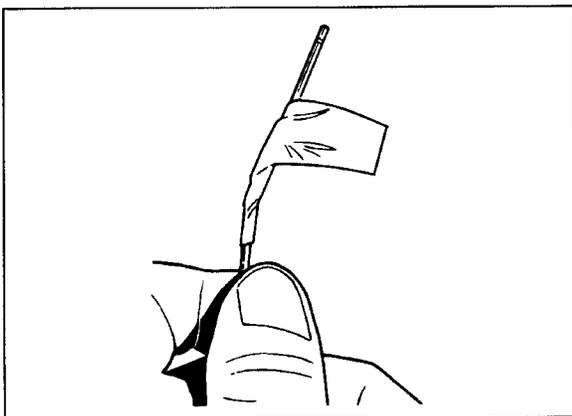


3. Solder the completed splice using only rosin core solder.
 - a. Wires and splices must be clean.
 - b. A good mechanical joint must exist, because the solder will not hold the joint together.
 - c. Heat the joint with the soldering iron until the solder melts when pressed onto the joint.
 - d. Slowly press the solder into the hot splice on one end until it flows into the joint and out the other end of the splice.

NOTE: Do not use more solder than necessary to achieve a good connection. There should not be a "glob" of solder on the splice.

- e. When enough solder has been applied, remove the solder from the joint and then remove the soldering iron.
4. Insulate the soldered splice using one of the following methods:
 - a. Silicon tape (provided in the wire repair kit)
 1. Cut a piece of tape from the roll approximately 25 mm (1 in.) long.
 2. Remove the clear wrapper from the tape.

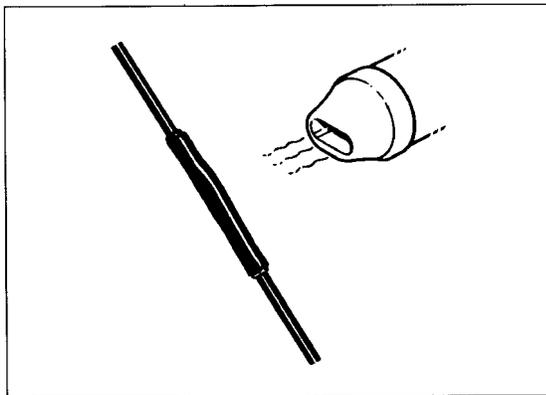
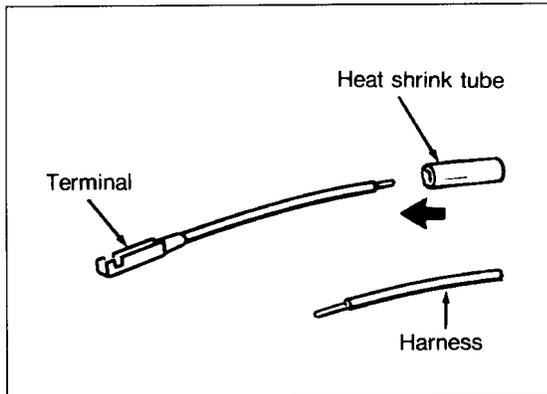
NOTE: The tape will not feel "sticky" on either side.



3. Place one end of the tape on the wire and wrap the tape tightly around the wire. You should cover one-half of the previous wrap each time you make a complete turn around the wire. (When stretched, this tape will adhere to itself.)
 4. When completed, the splice should be completely covered with the tape and the tape should stay in place. If both of these conditions are not met, remove the tape and repeat steps 1 through 4.

NOTE: If the splice is in the engine compartment or under the floor, or in an area where there might be abrasion on the spliced area, cover the silicon tape with vinyl tape.

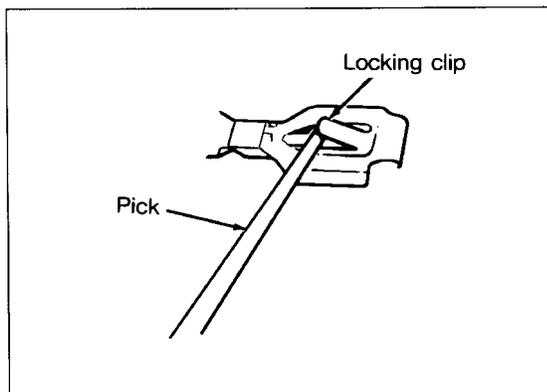
WIRE, TERMINAL AND CONNECTOR REPAIR



b. Heat shrink tube (provided in the wire repair kit)

1. Cut a piece of the heat shrink tube that is slightly longer than the splice, and slightly larger in diameter than the splice.
2. Slide the tube over the end of one wire to be spliced. (THIS STEP MUST BE DONE PRIOR TO JOINING THE WIRES TOGETHER!)
3. Center the tube over the soldered splice.
4. Using a source of heat, such as a heat gun, gently heat the tubing until it has shrunk tightly around the splice.

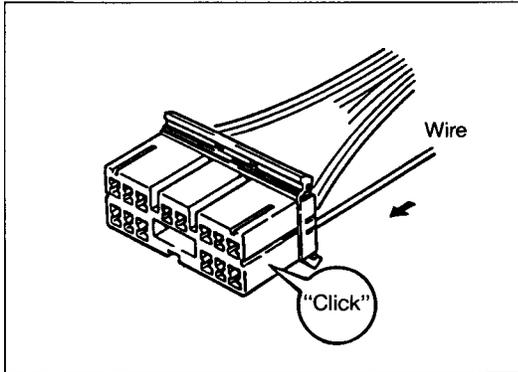
NOTE: Do not continue heating the tubing after it has shrunk around the splice. It will only shrink a certain amount, and then stop. It will not continue to shrink as long as you hold heat to it, so be careful not to melt the insulation on the adjoining wires by trying to get the tubing to shrink further.



Step 4. Install the terminal into the connector.

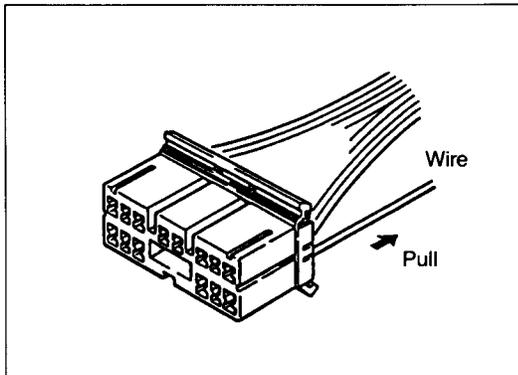
1. If reusing a terminal, check that the locking clip is still in good condition and in the proper position.
 - a. If it is on the terminal and not in the proper position, use the terminal pick to gently bend the locking clip back to the original shape.
 - b. Check that the other parts of the terminal are in their original shape.

WIRE, TERMINAL AND CONNECTOR REPAIR

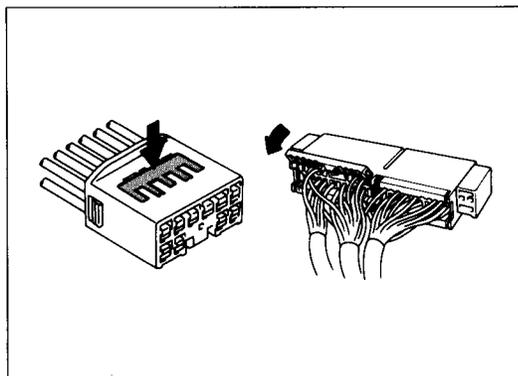


2. Push the terminal into the connector until you hear a "click".

NOTE: Not all terminals will give an audible "click".

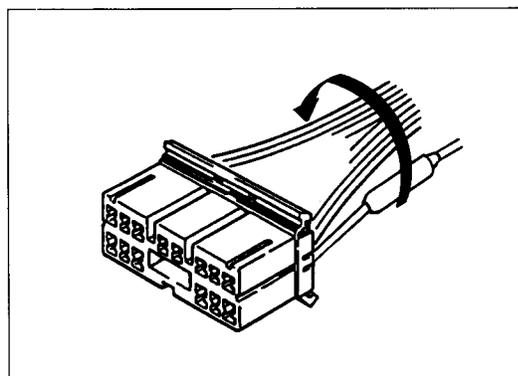


- a. When properly installed, pulling gently on the wire lead will prove the terminal is locked in the connector.



3. Close terminal retainer or secondary locking device.

- a. If the connector is fitted with a terminal retainer, or a secondary locking device, return it to the lock position.



4. Secure the repaired wire to the harness.

- a. If the wire is not in the conduit, or secured by other means, wrap vinyl tape around the bundle to keep it together with the other wires.

WIRE, TERMINAL AND CONNECTOR REPAIR

ASSIGNMENT

NAME: _____

- 1. Explain which type of wire is used when current flow is high.**
- 2. Explain what is mean by system polarity and how is it used today.**
- 3. Explain how the colors of the wire insulation are used and give an example.**
- 4. Explain how wire is sized, different sizing systems, and provide examples.**
- 5. Name the correct type of solder used for electrical repair repair and why**
- 6. Outline the procedure for “Tinning an Iron”.**
- 7. List the rules for good soldering.**
- 8. Outline in detail the correct procedure for splicing a new wire end on.**
- 9. When and why is a heat gun used?**